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ABSTRACT

Three principal conclusions were reached by a study of the potential for cable television at Stanford University in connection with its use in the surrounding community: (1) Stanford residents should have an opportunity to receive cable television services soon; (2) beyond residential cable service, a broadband cable system offers Stanford many opportunities for enhancing campus life, supporting the main educational mission, and more effectively communicating with its neighbors; and (3) a campus-wide broadband cable network would create an enriched communications environment within the university. Background information and explication for these conclusions make up the major part of the report. Specific topics discussed include Stanford's utilization of a campus-wide broadband communication system (entertainment and personal, public service, administrative and utility uses, and instruction and research); technology and design considerations for institutional and residential systems; Stanford system requirements; economics; and operating options. Following a summary, five specific recommendations are offered. Appendices provide a glossary for the layperson, data on Stanford demographics related to residential cable systems, and a preliminary analysis of the City of Palo Alto position. (LMM)

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REPORT OF THE
AD HOC TASK FORCE ON CABLE TELEVISION
STANFORD UNIVERSITY

MAY 1982

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REPORT OF THE
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REPORT OF THE
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I. General Conclusions

Although the initial charge to the Task Force was confined to a study of cable television, our work has made it clear that the transmission of television signals is only one attribute, albeit the best understood and most widely used, of broadband[1] cable communications. We also found that the needs of a research university call for consideration of a wider and more interdependent set of telecommunications and information technology issues. Finally, the particular attributes of Stanford, where the vast information requirements and resouces of the academic departments and laboratories exist in close proximity to the residences of a large number of faculty and senior staff, present an opportunity without parallel in many other communities for especially creative and productive uses of broadband technology.

As we came to understand these implications of the emergence of cable television, locally and nationally, we reached several principal conclusions regarding cable television and Stanford.

1. Stanford residents should have an opportunity in the near future to receive cable television services if they choose. While the technology, economics, and structure of cable TV are still in a state of flux, the industry is sufficiently mature and stable to insure continuity and quality of service. In the local area, Mountain View has awarded a franchise to a private company (Viacom). Palo Alto appears likely to approve cable television before year end. The cities of Menlo Park, Atherton, and East Palo Alto have formed a cable television consortium; we expect them to reach

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(1) Some of the terminology in this report is peculiar to the fields of cable television and data communications. The reader is directed to Appendix A for definitions of selected terms.

a decision somewhat later than Palo Alto. With cable television having reached its present state of technical development, and with its growing utility, we believe the time has arrived to introduce residential cable television and other cable services in the Stanford community.

2. Beyond residential CATV service, a broadband cable system offers many opportunities for enhancing the quality of campus life, supporting Stanford's main educational mission, and more effectively communicating with our neighbors. Decisions regarding cable television should be linked wherever possible with the development of the campus information network (SUNet), modifications of campus energy management, security, and fire alarm systems and revisions in the telephone system. In this important respect, Stanford's needs may be substantively different from those commonly associated with the average U.S. community and entertainment cable television, and our system requirements may be more demanding than those of our neighboring communities.

3. A campus-wide broadband cable network will create an enriched communications environment within the University which can subsequently be widely used by the many departments and other units of the institution. Although it is impossible to specify exactly how organizations within the University will choose to utilize this flexible technology, innovation in the use of the cable facilities is a predictible outcome of the synergy between our instructional and research programs and broadband communications technology. An institutional commitment to providing broadband communications facilities campus-wide, whether or not in collaboration with surrounding communities or commercial cable interests, should be carefully and clearly made as soon as possible in order to permit planning where a choice of technology is necessary to move ahead (eg. energy management, data communication). To create the facilities and make them fully operational may take one to three years from the date of a decision to proceed . In the interim, planning for other research, instructional, cultural and administrative uses of the broadband technology can be considered and the lead time used to develop proposals and funding sources.

The report that follows provides explication for these conclusions. More specific recommendations for consideration may be found in Section VIII of the report and in Appendix C.

II. Introduction and Background

Broadband communication is not a new issue at Stanford. In 1970 an ad hoc University committee recommended Stanford's participation in the cable system then under discussion by Palo Alto. The Palo Alto City Council, however, concluded that building a system at that time would not be economically justified and would quite likely become technically obsolescent within a matter of a few years because of rapid developments in the industry. In 1973, Stanford was unsuccessful in obtaining a foundation grant which would have established an experimental educational cable network. Since then the issue lay more or less dormant at Stanford and in the mid-Peninsula area until 1980, when Mountain View and Palo Alto began to take renewed interest.

At the University in early 1981, the Task Force on the Future of Computing report included a central recommendation urging creation of a digital network for Stanford. SUNet, the Stanford University Network, has since been in the planning and development phase. It will, very likely, employ the same underlying broadband cable technology that is used in modern cable television systems (e.g. CATV systems), the subject of the charge for this Task Force study.

Other universities (e.g. Brown, Princeton, Illinois, Cornell, Dartmouth, Michigan State, University of Arizona) are moving in similar directions, some on their own and others in collaboration with their neighboring communities or a cable television system operator.

On a national level, the number of communities with cable has grown rapidly, spurred largely by the variety of entertainment and news television channels available only to cable subscribers. Some 4500 cable systems now operate in about 10,000 cities, and cable is now available in about 32% of all TV homes. Moreover, the pace of wiring communities, especially in the larger urban areas, has accelerated. Franchises to cable operators ("Multiple System Operators" and local companies) have been recently granted or are in negotiation in many of the remaining major metropolitan areas. Within several years, few urban areas will be without cable service. Several factors have contributed to this surge of nationwide activity and the renewed interest at Stanford and in the neighboring communities.

- o Technical innovations have greatly increased broadband cable delivery capacity and the variety of services offered. Satellites were first used for national distribution of entertainment and information to local cable

operators in 1976. Now there are about a dozen U.S. and Canadian satellites in operation for video purposes and it is certain that there will be many more in the next decade. Satellite transmission has multiplied the number and variety of video services available to paying subscribers and, in effect, has led to the establishment of several nationwide special-purpose television networks comprised of satellite service suppliers and local cable operators.

The signal capacity of coaxial cable systems has increased through the development of improved component technology to the point where the industry today commonly provides over 50 channels per cable. Cable systems can be designed to send signals in either direction, permitting feedback to the point of origin and communication with other users. However, it is estimated that of the 25.9 million homes currently served by cable television, only about 800,000, or 3%, currently have interactive, two-way capability. All new systems in major urban areas are expected to be designed for two way transmission.

Other technical advances permit "tiered services" and "addressable delivery", i.e., economical delivery, on demand, of selected channel signals or programs to specific subscribers or groups of subscribers. These innovations support limited distribution networks such as channels dedicated to the continuing education of professional groups or selective program delivery of special sports or entertainment events. (The 1981 Big Game was one of the first intercollegiate football contests to be distributed in this manner.)

- o Deregulation. Until the mid-seventies the FCC enforced highly restrictive controls over cable television. Only after 1972, for example, did the FCC allow cable companies to move into the nation's 100 largest television markets. It was not until 1976 that the FCC dropped regulations prohibiting cable operators from showing films less than three years old or sports regularly carried on broadcast television. In 1977 a federal court overturned most of the anti-pay cable television regulations, spurring the current tide of expansion. The trend toward deregulation seems to be continuing and legislation which would further reduce local governments' power to regulate rates and services offered to subscribers by franchisees has been introduced at state and federal levels.

- o Diverse Programming made possible by relaxing FCC regulations and satellite transmission has proven to be very appealing to the subscriber and profitable in the industry. Simply put, the main attraction of entertainment cable television is no longer the enhancement of local television signals or the importation of network channels from cities just out of the normal reception range. Pay television aimed at special audiences is the fastest growing segment of the cable market. Fourteen and one-half million homes now subscribe--five times as many as just three years ago. It's highly likely that we will see both quantitative growth and greater diversity in the years ahead as the industry seeks to expand its market. An important area of growth will be in the delivery of videotext and other interactive services not available over the air.

- o Text oriented uses of cable technology are becoming more common, and are viewed by many as a new frontier for broadband cable communication. An example of a simple text oriented use of a cable system employs a low cost character generator to display a stream of characters on a particular channel for advertising, weather information, news, cable program information or similar purposes. Teletext service exemplifies the next level of capability, permitting hundreds to thousands of pre-defined frames (TV screens of information) to be selected for viewing by the user in a fashion that appears interactive. Videotex(t) service is the next level of sophistication and permits true two-way communication between the user and the sources of the information (e.g. computers). Experiments by the Japanese (Hi-Ovis), by the U.S. Department of Agriculture (Green Thumb), and others have demonstrated the capability of cable for interactive transmission of text and other information forms. Several European government agencies (British Telecom, Deutches Bundespost, French PTT) already have systems of interactive text retrieval in place (Prestel, Oracle, Ceefax, Antiope). A number of experiments are being conducted in the United States, largely by television networks (CBS, FBS), publishers (Knight-Ridder, Gannett, Dow Jones, Times-Mirror), by cable television system operators (Cox, Warner-Amex and Times-Mirror) and by AT&T, to gain experience with the logistics and economics of text transmission by broadband cable. While a technical standard has not yet been set in the U.S., it seems likely that the Canadian system (Telidon) or a variant of it will

become the standard for videotex transmission in the U.S. in view of the fact that AT&T has adopted it as their videotex system.

- Interactive uses of cable have been extended well beyond the capabilities associated with text or video image display. Reader's Digest (the SOURCE) and CompuServe have instituted commercial "information utilities" (providing data-base access, data processing, consumer transactions, etc.), currently available to terminal and micro-computer owners by telephone, but designed to be accessed ultimately by means of broadband cable. The SOURCE has recently announced arrangements with four national cable system operators (Cox, Cross Country, Storer and United Cable) to offer their information utility services to cable subscribers.

  The two-way data transmission capability of modern broadband cable systems makes it possible to interconnect home computers, terminals, office computers (e.g., word processors) and large computer facilities by a single coaxial cable (or cable pair) with sufficient capacity to substitute for tens of thousands of pairs of conventional telephone wires. The technology is now available in the marketplace and the products are becoming more plentiful and less expensive as the production volumes increase.

- Transaction applications such as shopping, bill paying, banking and utility meter reading are expected to become important uses of cable. A number of local governments, industrial facilities and other institutions utilize or plan to utilize cable for energy monitoring, security, and fire warning systems. Some communities are planning to use cable, at a considerable savings over telephone lines, to synchronize traffic lights. Many new cable systems have committed channel capacity to an institutional network facilitating two-way transmission of data and video between the educational, health, cultural, and public service facilities (e.g., police, fire, libraries, etc.) in the community.

While in the past much of the utilization of cable rested on the distribution of broadcast television signals, there seems to be little doubt that cable systems will become over time an extremely flexible and inexpensive means of communication among people and machines.

III. Stanford's Utilization of a Campus-Wide Broadband Communications System

The Task Force attempted to identify some of the principal ways Stanford could use and benefit from a campus-wide communications system employing broadband cable technology. A system based on this technology would be capable of simultaneously supporting a high volume of data communications and a large number of video (e.g. television) channels. The system could be interconnected with similar operations in the surrounding communities to permit the exchange of video and data signals. Bidirectional capability of the broadband coaxial cable system could be developed to permit any terminal or computer in the system to communicate with any other.

The Task Force looked at how other communities and universities have used or are planning to use cable communications; we talked with industry representatives and consultants; and we investigated the needs and interests of many sectors of the University.

We've chosen to describe potential utilization under four headings. Under each we list both video and non-video applications to emphasize the versatility of a broadband communications system and the range of opportunities it would open up for the University community.

A. Entertainment and Personal

A campus broadband communication system would be used to deliver television programming to subscribers in the faculty housing areas, student residences, the Stanford hospital, and to other users on the campus. Though the residential cable system need not be the same as the system serving instructional, research and administrative needs (see Section V. Stanford System Requirements), it should be thought of as an integral part of an overall campus system with interconnection to the other parts.

Cable programming can be divided into four basic categories: retransmission of local television channels, the importation of distant broadcast stations, programming originated within the local system, and special programming and services received from satellites or links to other cable systems. Currently common practice is to charge subscribers according to the number of services they wish to receive. For a basic fee a standard tier of services consisting of local and distant VHF channels, FM signals, local programming, and perhaps one or two special services would be provided. For a premium, an additional tier of pay television channels would be available.

We believe that the availability of cable television would not be likely to change the basic television habits of the Stanford community with respect to entertainment programming. Subscription could be entirely voluntary (in faculty and staff housing) and

would not influence the noncable reception of local television, except to the extent that multiple unit dwellings with local antenna systems (e.g. MATV systems) might be required to convert as a group to CATV.

A broadband communication system would also offer certain non-video entertainment and personal use options. By means of the network, personal computers could be used to access data bases (e.g., stock market reports) or each other (e.g., for direct electronic mail); homeowners might wish to use the network to take advantage of security and fire alert systems, and perhaps eventually to conduct certain kinds of personal business transactions, such as banking or shopping.

B. Public Service

The Task Force believes that public service applications for a broadband communications system for public service would largely involve local programming. A Stanford channel could carry an information bulletin board of campus events, timely registration and class scheduling information, news of student employment opportunities, meetings of the Faculty Senate, and a host of other programs of interest to the Stanford community. Other kinds of programming such as sports, drama, music, public lectures, and news programs originated at Stanford would be of interest not only on campus but to the neighboring communities as well.

We believe that cable television can be used imaginatively to create a better sense of community at Stanford and to promote better understanding of the University among the surrounding communities.

The Task Force recognizes that the origination of programming at the University would pose additional requirements in an already strained budgetary situation. Neighboring communities and other users would be expected to share fairly in the costs, as the price for enjoying a unique and otherwise unobtainable source of local programs.

C. Administrative and Utility Uses

A broadband coaxial cable system could be used for a wide range of administrative and support purposes. The Task Force has not investigated the economics of these applications, but the fact that other institutions have adopted them suggests that Stanford should evaluate their potential advantages and cost savings.

1. Safety and Security—Stanford's extensive geography, the remoteness and seclusion of certain parts of the campus, and the large number of buildings create an added burden for the fire and police departments. A number of applications such as auxiliary fire and smoke alarms, intrusion alarms, remote television monitoring, emergency broadcasting, and medical

emergency or security alarms could be supported by a broadband cable system connecting buildings, dorms, libraries, laboratories, and homes to the main campus police and fire stations.

2. Physical Plant Management--A number of campuses have begun to use broadband coaxial cable networks for energy management. This appears to the Task Force to be a potentially important area of cost containment, considering the very steep projections of energy costs over the next several years. The Task Force representative from the University Utilities Systems Department has indicated that plans are already under consideration for a new generation energy management system and has guessed that the cabling costs, which could be eliminated by sharing a broadband cable, would be over $100,000.

3. Office Technology--Office work and interoffice communication have begun to change as innovations such as electronic message and text editing systems have been introduced at Stanford. The ultimate success of these experiments, and successor applications, will probably depend on how well they're interconnected through telecommunications networks. At present, it appears to the Task Force that there are a number of office systems which operate independently of each other because no other choice is available. The Task Force believes there would be opportunity to make some of these office systems more valuable and cost-effective if they were part of a larger campus-wide broadband communications network. Cost containment and reductions would become feasible by sharing equipment (e.g. expensive printers) among office systems by means of the network.

4. Voice Telephone Circuit Multiplexing--The same broadband cable system which carries data could be used to carry multiplexed telephone circuits. The highest probability for early employment of the cable in this use is for interconnection between nodes of a distributed telephone switching system, which could be done with broadband in a way which is compatible with the telephone company (i.e. T-1 Carrier). This use of the broadband cable would displace costs of separate cabling.

5. Administrative Computer Applications Interfaces--There is a growing number of distributed administrative data processing applications which require interaction (e.g. data transfer) with each other. The Stanford Center for Information Technology identifies about ten separate computers with administrative applications needing to communicate in the Medical Center alone. Current methods for moving information among administrative computers range from transferring tapes between the respective computers supporting these applications to electronic data transfer by means of interconnection with dedicated telephone lines. The equipment and telephone circuits required in the latter case are quite expensive at the high data transfer rates which could be easily and economically achieved over the broadband system.

6. Departmental Support Systems--Access to existing systems and files from departmental terminals for administrative purposes could be facilitated by a broadband network. The campus directory, operator's telephone number assistance system (OAIS system in telecommunications), stores ordering and other applications could be made available for update and retrieval,

where appropriate, with terminal input and output replacing forms and reducing paper flow. Distribution lists, the Administrative Guide and other instructions and administrative manuals could be kept on file and made available via the broadband network.

D. Instruction and Research

The Task Force believes that the opportunities created by the swift spread of cable television and by recent breakthroughs in information technology should be considered in the context of Stanford's educational mission. Despite recent events that make it technically and economically feasible to distribute educational materials to a much larger number of individuals, delivery of instruction by television does not fit easily into Stanford's existing instructional pattern.

A notable exception to the current pattern is the Honors Cooperative Program (HCP) which utilizes the Instructional Television Network operated by the School of Engineering. Courses from all nine Engineering departments together with Applied Physics, Computer Science, Mathematics and Statistics are televised. Through the HCP, part-time graduate students working full-time in local high technology organizations can do graduate degree work part-time.

The instructional television program in Engineering is now limited to four simultaneous broadcast channels. A cable system linking the campus with local industry could increase the network's delivery capacity. However, at least in the initial phases expansion would be limited through line transmission to the geographical area covered by the cable system or systems with which Stanford chooses to affiliate.

Another option worth considering is the transmission of video-tape replays of selected Stanford Engineering and Science courses and seminars into subscriber homes during evening hours. We believe, for instance, the local scientific and engineering community could be interested in a course on data structures or a new course on Very Large Scale Integration (VLSI) presented by a leading expert in the field. Experience gained from distributing selected courses in these fields, where we already have programs available, would provide the University with information on delivery of educational programs in other fields (e.g., medicine, the humanities) to select cable audiences off-campus. The Task Force believes that eventually, once this technology is better known and the environment is a comfortable one at Stanford, cable television might be more widely used by schools and departments to conduct educational programs off campus.

Several schools (e.g., Business, Medicine, and Engineering) are active in continuing education, but they offer small, highly selective programs of advanced training for executives and professionals. This pattern is consistent with Stanford's educational

strategy of providing personalized instruction in the classroom to a limited number of students in a residential setting. On the other hand, future economic and technical developments may dictate greater emphasis on distance learning for purposes of advanced training in areas of institutional specialization, and we should not foreclose this possibility.

The possible uses of a digital network by research programs are discussed in the "Report of the Task Force on the Future of Computing" and will not be repeated here. A broadband cable network can support most, if not all, of those uses. Economics and availability of components however, may make certain uses more appropriate to a baseband network (e.g. Ethernet) which could be connected to the broadband network to permit communication between the two.

In addition to the research uses associated with digital data applications of the broadband network, there is great potential for non-digital research uses which only a broadband network would permit. For example, video imagery and research related to combined video-digital information delivery would be possible. This type of research activity (e.g. experimental video delivery systems for indexed frames of library materials) has been proposed in the past but was not supportable by existing university facilities. In addition, various types of social science, business and communications research requiring video and/or audio information dissemination and audience reaction would become possible. A two-way cable system would permit various feedback opportunities including communications research (e.g. impact of programming formats), multiple choice question response, satisfaction surveys, etc.

With decentralized computing already well established at Stanford, the development of a network system to link local computers and terminals with each other and with larger service facilities is essential. A recent inventory of campus computers shows that there are at Stanford 20 large capacity computers (mainframes), about 250 minicomputers, at least 122 microcomputers, approximately 100 word processors and over 2,000 computer terminals. If the inventory had included microcomputers owned by faculty, staff, or students the figures would have been much higher. In response to this trend the University has decided to move forward with the development of the Stanford University Network (SUN or SUNet). While the Task Force felt that analyzing alternative technology for such a network would be going beyond its charge, broadband coaxial cable technology is clearly sound from the engineering standpoint and appears to be cost effective for an integrated communications network incorporating high-speed digital data distribution. Other universities (e.g. Brown, Cornell, Illinois at Urbana) have made this their choice. Interconnection of Stanford's broadband communications system with Palo Alto and other communities could provide an extremely convenient

means for Stanford faculty and staff living in those communities eventually to tie into major computer facilities at Stanford from their residences (see Appendix B for information about the residential distribution of faculty and staff). Interconnection of the campus with the Industrial Park might also be desirable to facilitate communication and collaborative research between scientists there (e.g. EPRI, Alza, Syntex, Xerox, IBM, HP, etc) and colleagues at Stanford in areas where it is appropriate.

The Task Force believes that a broadband cable network could be employed in a number of specific ways to improve instruction and research and found the following illustrative uses of particular interest.

1. Educational programming from other universities, museums, hospitals, and other sources could be brought in via satellite, pre-recorded tape and other means from around the world to augment and extend the experience of our students. Foreign language broadcasts and the proceedings of the House of Representatives which are currently available are cases in point.

2. As teleconferencing facilities become more widely available, colleagues from around the country could be brought together at relatively low cost for scholarly collaboration, continuing education or alumni meetings.

3. Courses taught by master teachers might be videotaped for transmission at a time subsequent to their retirement, and Stanford appearances by significant individuals might be recorded. Campus lectures, debates, conferences, concerts and public performances which often conflict with each other, might be made available for later transmission.

4. Residential education at Stanford would be a likely beneficiary of instructional programming, both through distribution of lectures and seminars among the residences and by access to videotaped lectures of notable scholars. The videotaped engineering courses, now in heavy demand at the Engineering library, could be broadcast for local viewing in dormitory rooms.

5. A sophisticated broadband information network could serve as a laboratory for the study of human communication patterns. Much of the inital impetus behind the Stanford proposal of 1973 derived from this potential. This area of scholarly interest is of considerable significance to the Institute for Communication Research in the Department of Communication, to the Center for Information Technology and to other academic and administrative units.

6. The Department of Communication's preprofessional study programs in broadcasting and television production would be enhanced. Students and faculty in other departments (e.g. those interested in expanded use of educational technology) could also acquire experience in video production and distribution. The system could also supply video programming to support purposes of the same kind as KZSU supports with radio broadcasting.

7. LCITS, the student computing facility, and its successors could be made more easily accessible to students through further physical decentralization, including locating terminals in student residences and employing multiple smaller computers in a distributed system. Common communications cable wall outlets distributed throughout the campus would permit movement or relocation of student access by simply unplugging equipment at one location, moving it and plugging in at another.

8. Access by individuals to external networks and data bases would be increased. This aspect of a broadband communications system is articulated in the report of the Task Force on the future of computing at Stanford.

The Task Force has concluded that while cable television is important to many campus residents, it is but one of several important dimensions of a campus-based broadband communications system. It should be underscored, however, that entertainment television is an important aspect of community life and that it may be the driving force behind providing the outlying residential parts of the campus with other benefits of the system.

IV. Technology and Design Considerations - Institutional vs. Residential Systems

By way of background, it is useful to consider some of the characteristics of broadband cable technology, its current limits and the way it is commonly applied and utilized in communities, in industry and in other institutional settings.

Cable television or broadband cable involves running one or more coaxial cables from a central signal receiving and distribution point (the "headend" or distribution center) to each individual subscriber in a residence or place of work. A "trunk" cable is branched into "feeder" cables which are in turn "tapped" at each location where service is to be delivered and a "drop" cable connected from the feeder to the location of the device to be connected. The drop is "terminated" with a connector (e.g., a wall plate and plug) to which a television set, terminal or computer interface may be connected.

Broadband cable system technology is capable of supporting a wide spectrum of uses. Virtually any information that can be converted to digital or analog signals may be carried in either direction on broadband cable. Further, the high capacity of modern multi-cable broadband systems can provide low cost channels to satisfy the TV-video requirements of a community with considerable margin available for other uses.

At one end of the spectrum, in the industrial setting, broadband systems may be dedicated to process control networks, tying together sensors and computers, visual/video monitoring, and production control functions while providing high system immunity to external electrical noise. At the other end of the spectrum, in the conventional small community, the cable system is likely to be used entirely for entertainment television. Community (CATV) systems in most cases provide off-air entertainment channels from surrounding communities and metropolitan areas with improved quality over that obtained from a private antenna. Some distant television stations and satellite or microwave supplied premium services (e.g. HBO, Showtime) might also be included. The cable system engineering and components will differ for these two examples to accomodate factors such as the environmental differences between a factory and a residential community, the distances over which the signals are carried, comparative importance of reliability and cost of system failures, differences in number and type of signals, and signal level and balance requirements of different receivers and transmitters. The two example systems would look very similar to a lay observer, though the "architecture" and engineering would differ significantly, resulting in important incompatibilities which we will discuss briefly later.

In recent years, the ability to design and build broadband cable systems that will perform a wider range of functions cost effectively has improved. Basic components (e.g. passive connectors, amplifiers, cable, etc.) have been continuously improving in specifications, making it easier to design a system to provide high signal quality over a wider range of frequencies and uses. A few years ago, system designs were for capacities (bandwidths) of 200-220 MHz, equivalent to about 32-36 television channels. Now there are about 26 commercial and educational broadcast television stations which can be received and placed on cable systems in the bay area, which would leave only 6-10 channels available for all other purposes on a 32-26 channel cable system. Today, many systems are being installed with two cables, each capable of providing 400-440 MHz of bandwidth. The two cables have a total capacity equivalent to about 108-120 television channels, though these may not all be usable for technical reasons. Practically all of these systems are being designed for uses which include both video and data, with bi-directional signal transmission capability.

The contrast between uses of a typical modern residential community system and a general purpose institutional system to serve the business, government and educational sectors is not as marked as the earlier comparison between a single industrial setting and a conventional residential system, but is still very substantial and underlies the decision to separate or integrate the two. To illustrate, let us consider two hypothetical systems of the same total capacity (e.g. two cables, approximately 800 MHz combined bandwidth), one in an urban residential setting and the other in a non-residential University setting of the type and complexity represented by the Stanford academic/business campus. Further, let us allocate uses to the bandwidth with accomodation for growth over the next 5-7 years, even though such a projection is conjectural.

In the residential setting, the two-cable bandwidth might be allocated to provide for 25-50 channels of broadcast television from the surrounding area, 5-20 channels of satellite and microwave delivered entertainment, sports, news and special programming; 1-4 channels of local community access (videotape and live programming), 1-3 channels for home security signals, 1-3 channels for meter reading and traffic signal control, 2-4 channels for videotex/teletext, and 1-2 channels of continuous weather data and local advertising.

By contrast, the University system might need 10-30 channels for data transmission, necessitating allocation of 18-20 channels to protection bands to avoid interference between the the two way data paths, 2-8 channels for telephone switch interconnection and other voice two-way communication, 1-2 channels for energy management system signalling, 2-4 channels for police and fire signalling, 2-4 channels for video

observation and security, 6-10 channels for educational programming, 1-2 channels for access control systems, and 2-6 channels for institutional teletext/videotex and special events broadcasting, and a substantial allocation to experimental research uses (e.g. hi-resolution graphics research, video image/videodisc retrieval, etc.).

There is no apparent way to support the sum of the projected uses for both the residential and university examples given above on a single pair of cables which would service both communities. There is, however, enough overlap in the assignments and uses so that three cables might be made to carry the combined services. The economic and design trade-offs between a common three-cable system vs. separate two-cable systems is affected by many factors but would be expected generally to favor the separate two-cable configuration.

More important are the limitations associated with an architectural choice and related technological incompatibilities and component availability. The equipment available in the marketplace is generally designed to support one of two popular ways of dividing the cable bandwidth for bi-directional communications, called sub-split and mid-split. A sub-split system allocates most of the bandwidth (approximately 360 out of 400 MHz) to one direction, from the headend or distribution hub to the receivers. Sub-split systems therefore support a large number of one-way channels (e.g. 54 per cable) which is suitable to residential requirements. Mid-split systems carry a larger fraction of usable bandwidth (15-20 channels) for transmission in the reverse direction. Mid-split systems sacrifice some of the total bandwidth to avoid interference between the forward and reverse transmission channels. Mid-split architecture would support the high volume of institutional data uses where sub-split could not.

The devices (e.g. converters, tranceivers, modems, etc.) that are available to attach to mid-split systems do not as a general rule work on sub-split and vice versa. The amplifiers and headend equipment are designed and configured differently as well. It is not practical as a result to combine the two architectures throughout a system (e.g. one cable of each) and it is substantially more expensive to support both types for separate residential and institutional settings even though a common distribution center is used. It is not difficult, however, to place program signals or channels originating from some source (e.g. an antenna) onto the same or different channels of both systems at the distribution center. It is also not difficult to interconnect two separate headends or distribution centers and transfer programs or data between them. Content carried on channels of one system may then be transferred to the channels of a separate system if the bandwidth is available. Transfer of data between systems through two distribution

centers is not necessarily straightforward. The protocols for data may be very different between the two systems and architectures, necessitating complicated conversion processing to transfer it in a usable way between systems or devices attached to them.

Most large community systems being installed currently are sub-split. The trend in institutional systems is mid-split. Some proprietary broadband systems are neither. For example, Wangnet (a trademark of Wang Laboratories, Inc.) is based on two cables with no frequency splitting; one cable is used for exclusive transmission in each direction. Direct connection of Wangnet based equipment would appear to be generally incompatible with a mid-split institutional cable used for other purposes. Mitre Corporation, which has been a leader in advanced broadband system design research and development, also makes use of dual cables without frequency splitting and has concluded that there are substantial advantages to such an architecture.

There is no single industry standard for broadband cable systems architecture and design. Many successful systems are operating using a variety of designs, but the trade-offs, limitations and compatibility issues must be considered with care and the design choices made to best match the requirements of the cable uses with design characteristics and available products.

V. Stanford System Requirements

The Task Force has not attempted to develop specific technical standards, equipment requirements, or the design and layout of a campus broadband communications system. This is properly the task of an operating organization and a professional broadband system engineering design team. We feel reasonably confident in our ability, however, to reach some conclusions regarding the basic physical configuration and operating requirements of a system intended to serve Stanford's particular purposes.

The installation of a cable system on the Stanford campus would require a substantial amount of construction and physical plant improvement for cabling between buildings and cable distribution within buildings. The cable would be installed underground in the areas of the campus that are predominantly laboratories, classrooms, dormitories, and in the newer residential areas. The cost of underground cabling is very sensitive to the availability of existing duct space to house the cables. A survey of the campus duct system is necessary to determine the availability of duct space, according to the Utility Systems Department, and such a survey is currently underway for the non-residential main campus area. In some parts of the older campus residential areas the coaxial cable could be strung above ground from existing telephone poles. A comprehensive campus-wide institutional and residential system would involve approximately 26 miles of cable, about 87% of which would be underground.

From the discussion in Section IV above, it is apparent that institutional business and campus residential needs differ and that we can treat them as logically separate systems from the requirements and specifications standpoint, although they may make use of some of the same physical facilities (e.g. conduits, cables, headend equipment, satellite antennae, etc.) and share selected programming and data.

Some preliminary thoughts about the general requirements for the two systems are presented below.

A. Campus Residential System: The Stanford residential system would require no less than two cables to meet the projected bandwidth requirements for the anticipated uses. This system would deliver commercial services to subscribers comparable to those supplied in other local cable service areas with modern systems: FM signals, local and distant broadcast television channels, premium programming services and the other news, entertainment, public service, and sports channels would be offered. Initially at least two channels would be required for Stanford's exclusive use which would carry Stanford sports and entertainment, campus news, lectures,

cultural and performing arts events and other Stanford originated television programming, with the capability to restrict reception to on-campus locations. A bi-directional capability for interactive computer terminals and home computer connections as well as videotex, transaction processing and residential security and utility monitoring systems is a requirement. The more demanding of these in terms of system design is terminal and computer connection. Terminal data rates of 9600 bits per second or higher should be supported. The trunk and feeder cable system must permit drops at every residential unit on University property including faculty housing, dormitories and apartments, with the exception of those which are not contiguous with the rest of the campus or are to distant to be economically feasible. Signal strength, quality and related characteristics must be sufficient to meet the requirements of the intended uses throughout the system. For example, the signal levels provided at drop terminations throughout the system should be balanced within about 3dB and reverse direction cumulative noise must be minimized through branching and limitations in the number of amplifiers in cascade. The more detailed engineering requirements have not yet been ascertained.

B. Campus Institutional System: A bi-directional dual or triple cable trunk would be required to meet the requirements for institutional bandwidth while providing redundancy and reliability in service. The trunk and feeder cabling must link all the buildings in the core part of the campus and deliver sufficient signal to each to permit the anticipated number of drops to be supported, depending upon the uses and needs particular to each building. Intrabuilding wiring over an extended period must be flexible, permitting additional terminations (drops) and movement of people and equipment without re-wiring. Sufficient bi-directional data capacity is required to support Stanford's interactive terminal communications and high speed digital data transfer among computer facilities while providing capacity for a wide variety of other signal types (e.g. energy management, video, security, etc.). We anticipate the requirement to connect about 1000 terminals in the short term (3-6 months from activation) and as many as 10,000 terminal nodes in the long term. Termination of trunk or feeder cabling in buildings must be in areas which can be secured from public access and the system must provide for a high level of protection and immunity from noise ingress and tampering. Extremely high reliability must be provided for uses supporting utility systems (e.g. energy management, telephone trunking, etc.). The system should be capable of being balanced throughout to within about 2dB

variation in signal strength. It is expected that many carrier signals could be active simultaneously for both data and video transmission, with significant variations in the modulation characteristics over time. Further detailed specification is required.

Figure 1, on the following page represents what we consider to be a reasonable projection of the two contrasting allocations of the bandwidth of two cables for the estimated 5-year demands in Stanford's residential and institutional settings.

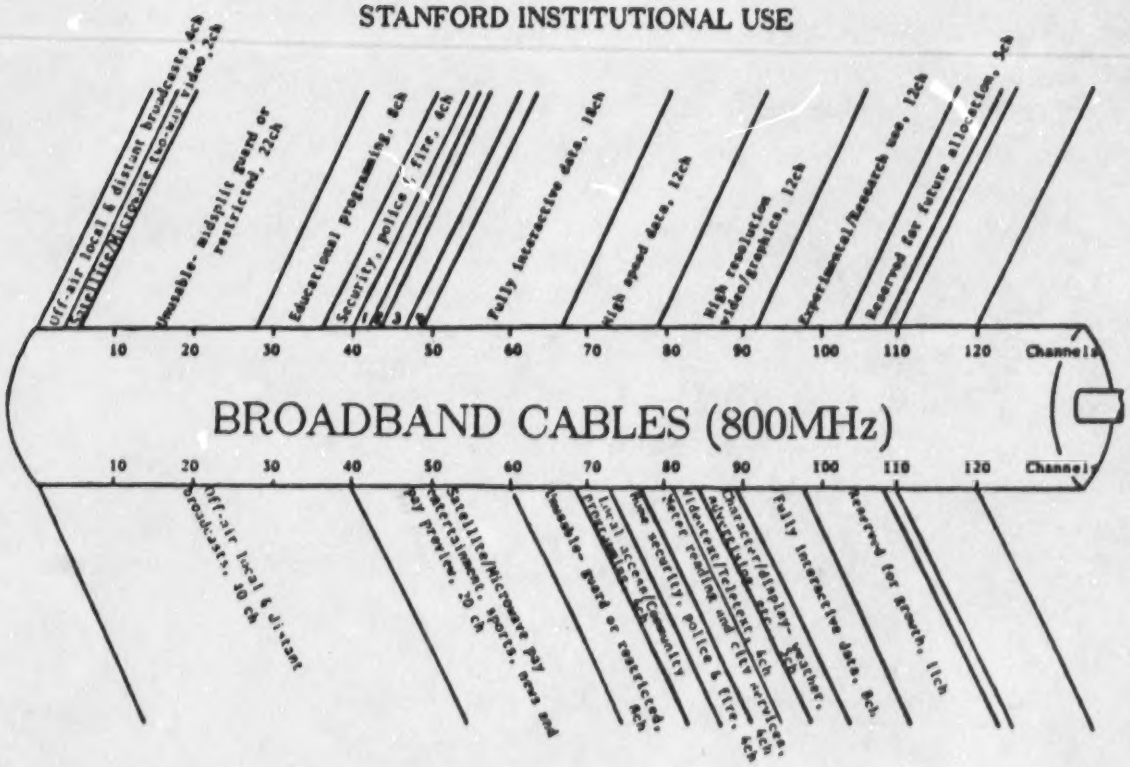
A two cable sub-split system would seem the likely candidate for the campus residential requirements and a two cable mid-split or dual cable bi-directional system would be minimally required to meet the institutional needs.

The two systems could be interconnected through a single campus cable communications center. This center, or hub, could also be directly linked with the City of Palo Alto's cable television system or those of other neighboring communities and to a dish (satellite earth station) for receiving and transmitting signals via satellite. The campus communications hub might well be located in Building 120, which will house the Department of Communication's television studio, due for completion in 1983. Other potential locations include the old Centrex building or one of the existing computer or telecommunications facilities.

Alternatively, the residential system might be serviced from the City of Palo Alto distribution center and interconnected with the campus institutional system for transfer of programming and data between the two by means of trunks between the hubs. The latter case might reduce the total headend costs if the residential system is sub-split and the institutional system mid-split. Separation (e.g. separate headend termination) of the residential and institutional systems could reduce vulnerability of the separate systems to problems in either one of them.

FIGURE 1

EXAMPLE ALLOCATION OF BANDWIDTH FOR TWO STANFORD SYSTEMS


STANFORD INSTITUTIONAL USE
Off-air local & distant broadcasts, 4ch
Satellite/Microwave two-way video, 2ch
Unusable- midsplit guard or restricted, 22ch
Educational programming, 4ch
Security, police & fire, 4ch
1
2
3
Fully interactive data, 10ch
High speed data, 12ch
High resolution video/graphics, 12ch
Experimental/Research use, 12ch
Reserved for future allocation, 5ch
10 20 30 40 50 60 70 80 90 100 110 120 Channels
BROADBAND CABLES (800MHz)
10 20 30 40 50 60 70 80 90 100 110 120 Channels
Off-air local & distant broadcasts, 30 ch
Satellite/Microwave pay entertainment, sports, news and pay previews, 20 ch
Unusable- guard or restricted, 8ch
Local access/Community 4ch
Home security, police & fire, 4ch
Videotext/Teletext, 4ch
Character/display - weather, 2ch
Fully interactive data, 8ch
Reserved for growth, 11ch
STANFORD RESIDENTIAL USE

1 Access control, 2ch
2 Energy Management, 1ch
3 Videotext/Teletext & Special Events, 4ch
4 Character/display - weather, advertising, etc., 2ch

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VI. Economics

The Task Force was unable to complete an economic analysis of a campus cable system because sufficient data are not available. Within the last two months, studies have been launched by the Task Force, by CIT and by the Utilities and Telecommunications departments to develop further cost data and initiate examination of other related economic issues.

Regardless of how Stanford chooses to introduce cable television and broadband cable communications, some costs would be incurred. Capital investment in the purchase and installation of cable and equipment would be substantial. If the University makes arrangements with a private company or becomes part of Palo Alto's service area for some or all of the systems described above, we would expect the capital costs to be assumed entirely or in substantial part by the operating entity which would receive revenues from subscribers. Stanford would contribute certain physical facilities (e.g. conduit space, headend space, etc.) and the capital cost of constructing the studio in Building 120.

The annual operating costs for the Stanford Institutional System would include at a minimum operation and maintenance of the cable plant and headend, the campus studio and the communications center, cost of programs originated by Stanford, and amortization of institutional system equipment, which is predicted to have an effective life of about five years.

Certain of these costs might be offset by savings through consolidation and reduction of current data communications facilities and operating expenses. Offsetting income might be derived from the system operator or the City through a rent for the studio, royalties on Stanford produced programs and from a return of some part of campus subscriber income. We believe that as a vital source of programming, Stanford would be in a position to negotiate for an economically favorable contract, either with a private company or with a local municipality. Additional offsetting usage fee income might be derived from on-campus and off-campus subscribers to certain central data facilities and network services, and other pay-per-use services.

The Task Force realizes that before the University can proceed with a decision on cable these economic issues need more analysis.

VII. Operating Options

There are three arrangements the University could make for bringing cable television to campus. The University could build and operate a wholly owned system; it could enter into a contractual agreement with a commercial cable operator to provide a private (non-regulated) system; or it could arrange with another community cable system such as Palo Alto's to provide cable services to the Stanford community. These three alternatives could be mixed to produce a combined strategy. For example, Stanford might choose to own and operate its institutional system and contract or franchise the residential system, or we might build a private system but arrange with the Palo Alto operator for the provision of programming and other services to the campus residential community. A fourth alternative, of course, is to eschew cable for the time being, but for reasons already explained the Task Force believes that it is time for the University to move ahead with cable television and a broadband cable communications system.

The advantage of owning and operating our own system is that the University would have total control. However, in the opinion of the Task Force there are overriding disadvantages to the University's entering into the business of distributing entertainment television services to on campus subscribers. There may be some legal obstacles to the University's providing residential entertainment cable, but the more compelling argument is that the distribution of commercial entertainment is too far afield from the interests or charter of the institution. In addition to the significant capital costs of building a residential system, we are concerned about financial risks, the University's lack of marketing expertise, and the University's direct participation in a sensitive business relationship with its faculty, staff, and students. Further, there are complexities in acquiring and managing delivery of entertainment program materials and in the potential interposition of the University in the selection of entertainment services for its residential community.

A second option is for Stanford to contract for the construction and operation of a private system to deliver services on Stanford property. This might be accomplished by an agreement in which a cable system operator owns the cable plant and supplies the operating, programming and related services or with some form of joint venture and ownership. Though the size of the market for entertainment television programming would be small by the standards of the cable industry, the proposition would be economically viable if high penetration could be secured. In addition, Stanford could offer other inducements and advantages in the form of programming, joint development of non-video applications and a combined institutional/residential laboratory for

mutually beneficial research and development activities. In order better to understand the feasibility of this option, the Task Force has invited several leading cable companies to discuss their interest in the Stanford community as a potential client.

The third option is to contract for services with one of the neighboring municipalities, presumably Palo Alto, Menlo Park, Los Altos or Mountain View. Under this arrangement Stanford would become a part of the city's cable television service area, at least insofar as the city's system would be extended into the campus boundaries. The conventional way for cities and counties to obtain community cable television is to grant a franchise to a private company, although Palo Alto is seriously evaluating municipal ownership and operation (see Appendix C). Authority to grant CATV franchises is regulated under California codes and, in Palo Alto, the authority is restricted by the city charter. As one might expect, the experience of communities with franchise operators varies. In some communities, cable companies have been responsible and have provided excellent service; in others, the experience has been unsatisfactory. Several national companies, which operate systems in a number of communities, have emerged with reputations for responsive, dependable and innovative service. The Task Force believes that it is possible for the Stanford residential area to be well served through a franchise arrangement, if the selection of the franchisee is competitive and careful. The presumed advantage of this option is that the University would be spared the costs of building a system in its residential area and would be able to reduce costs of some other aspects of extending the broadband cable to the other parts of the campus. The University would require dedicated channel capacity for its own uses and the freedom to develop its own residential and institutional services tailored to its special needs.

The Task Force believes there could be many benefits both for the City of Palo Alto and for the University in having the capability, under any of the various options, for linking the campus and the City. As a source of programming in the arts, education, sports, and public affairs, Stanford would add depth and variety to Palo Alto's system. In return, Stanford would benefit from the additional opportunities cable would provide for communicating with the citizens of Palo Alto, a good number of whom are Stanford faculty, staff or student families (see Appendix B) or otherwise connected with Stanford. However, the Task Force's understanding of this third option has been clouded somewhat by the City's interest in its own options regarding ownership and operation of a cable system (see Appendix C). Suffice it to say, the Task Force feels that no University decision can be reached until the City makes some basic decisions of its own and until we

understand fully how the City's choice of direction fits with our plans and requirements.

At this point the Task Force is not in a position to recommend which one of these three options might serve Stanford best, although it seems likely that either contracting with a private company or becoming part of the Palo Alto or Mountain View system is the way to go for the residential system, assuming that the supplier is willing to satisfy the design and service specifications to meet Stanford's needs. We believe the University should investigate the former in greater detail, and await further clarification of Palo Alto's position before reaching a final position.

VIII. Summary and Recommendations

Many observers believe that cable communications will become a significant feature in the everyday personal and work lives of most citizens, especially those closely connected with information, education, medicine, entertainment and performing arts, data processing, and administration. This means most individuals in the University community and many organizations on campus will in some way have to deal with cable communications before long and that we can expect development of an increasing level of dependence on this technology.

It is from this perspective that we make the following recommendations:

1. Stanford should work toward development and early installation of a two-way, interactive residential broadband cable communications system for our resident students, faculty and staff; and should investigate opportunities for interconnection with systems which serve those who reside in surrounding communities, principally Palo Alto. Though entertainment television and community video programming are recognized to be very important in determining the minimum facilities and capacity of a residential system and in providing short-term financial viability, we should exercise every influence to encourage that residential systems in the Stanford area are designed and constructed to accomodate non-video bi-directional signals and diverse future communications to the home.

2. Stanford should proceed with planning and developing of an institutional broadband cable communication system to meet our projected ten-year needs, notwithstanding the CATV plans and developments in surrounding communities. Stanford's system design should be sufficiently flexible to assure that interconnection with a campus residential (educational and entertainment) system and the institutional networks of other community systems can be reasonably accomplished. In addition, Stanford's system should be engineered to provide for opportunities to explore new and innovative aspects of the technology, support research uses on the campus and promote development of sponsored research activities.

3. Stanford should immediately initiate activities prerequisite to discussions or contract negotiations with external parties for a broadband communications system. These activities should include a complete survey of existing Campus signal duct capacity, refinement of operating costs

associated with the data, institutional and general purpose aspects of a comprehensive system, and economic analysis of institutional applications in building protection (access control, police and fire alarm systems, property surveillance), telephone system replacement and energy monitoring.

4. Stanford should conceive and implement a process to promote continued coordination of cable and related communications activies and create an organizational focus for cable communications and related information technology. In this respect it is important that the University develop some clear overall objectives and maintain a single point of contact to speak with one voice to outsiders regarding broadband cable communication and television. It's unlikely that this Task Force or any successor group will reach final conclusions about cable communications and other related issues. Without some type of unifying process the University will be forced to respond piecemeal to a series of important and costly decisions. Stanford's attractiveness as a franchisor or contract recipient of cable services depends in part on its rights to various programmatic materials including cultural, intellectual, entertainment, and athletic activities centered on campus and/or produced by the University. If the University spins these off separately it would weaken its negotiating position with potential franchisees and contractors.

5. Cable television and the related broadband cable communication issues are complex and demand administrative and professional staff time to analyze and resolve. The implications of the foregoing recommendations include a greater commitment of staff resources by the University to the support of institutional communications systems and networking to insure that we obtain the most we can from our investment in the technology. The Provost should take the initiative in assuring that staff and budget are allocated to conduct analyses, negotiations and continuing relationships with either the City or a private company and coordinate campus broadband communication facilities and communications networking activities.

APPENDIX A
TO
REPORT OF THE
AD HOC TASK FORCE ON CABLE TELEVISION
STANFORD UNIVERSITY

GLOSSARY FOR THE LAYPERSON

Analog/Digital

In reference to electrical signals, analog means that the value (e.g. voltage) of the signal may vary continuously over some range of values as with a sine wave. By contrast, digital signals only occupy discrete values; for example, the voltage may be either -5v or +5v to represent the binary values of zero and one to encode digital data.

bandwidth

The capacity of a channel, medium or signal source, generally expressed in terms of the range of frequencies that can be accomodated. A voice telephone circuit may accomodate a bandwidth of only a few thousand cycles per second. A fiber optic medium might be capable of accomodating a billion cycles per second. TV channels require 6MHz. Contemporary coaxial cables have a bandwidth capacity of 400-440MHz.

Broadband

(As contrasted with "baseband.") Used in the context of cable communications systems to distinguish the electrical characteristics of the signals placed on the wire. Broadband signalling employs the same kind of electronic principles that are used radio and television broadcast and reception, that is, a (high) frequency carrier signal is electronically generated and modulated with voice and video signals for transmission. Many stations or channels can transmit simultaneously because a small portion of the available frequency spectrum is assigned to and used by each and the receivers can be tuned over the range of assigned station frequencies. The power level required to propagate the signals on a coaxial cable is a miniscule fraction of that required to propagate a radio or TV signal into space around a broadcast antenna. The electronics are more compact. The shielded cable keeps the signal from escaping and protects the signal from outside interference.

CATV

Acronym for "Community Antenna Television", commonly used as a generic label for the cable television industry. Originally applied to community cable television systems where the major purpose was to share antenna facilities in order to provide better reception from a wider geographical area than could be obtained with a home antenna. Shared antenna facilities now include satellite earth stations and microwave antennas for reception of a wide variety of "pay TV" programming (e.g. HBO, Showtime, etc.).

channel

In television, the standard bands assigned to transmission of a picture and sound signals, a modulated video carrier and an audio carrier, to which receivers are tuned. Standards are applicable to broadcast and cable television channel characteristics to insure good image and sound quality and control interference among channels. Certain devices like high resolution video or graphics displays may require more bandwidth than is available in a single channel. On cable systems, the channel frequencies used for broadcast (off air) channels may be translated into different frequency bands on the cable.

Coaxial cable

Coaxial cable has metallic conductors (two or more) separated by an insulator ("dielectric") sharing the same axis - the center of the cable. The signal carrying wire is the center conductor, usually a single plated or stranded copper wire. It is surrounded by the layer of insulation material (e.g. a plastic "foam" or sleeve). Most coaxial cable has a single "shield", the second conductor, which is either braided wire (for small, flexible "drop" cables) or a solid metallic sheath or tube (for larger, CATV trunk lines). Coaxial cables used for cable television range from under 3/8" O.D. inside residences to 1" O.D. for "supertrunks". The larger sizes are used to reduce electrical (resistive/inductive) signal losses. A single coaxial cable provides the same signal carrying capacity as many separate strands of unshielded copper wire such as that used by the telephone company to connect telephone instruments. One coaxial cable may carry 52 television channels and/or a large number of other signals simultaneously to many users.

DBS

Direct Broadcast System(s). An alternative to cable systems for the delivery of television programming (one-way services). See MDS and STV.

fiber optic

In the context of communications systems, a fiber optic is a broadband medium which uses light to carry information instead of lower frequency electromagnetic radiation, like radio waves. Fiber optic cables and communications systems are available today for a variety of uses. Individual optical fibers can be fabricated and supplied in the form of cable containing one or many fibers. Fiber optics systems can be used to serve the same kinds of communications needs as broadband coaxial cable systems, but the methods of generating the signals and the technology are, of course, very different. Fiber optics have enormous signal carrying capacities but are not yet in very wide use. Still experimental; high cost of repair.

headend, hub or distibution center

The location in a cable television or broadband cable communications system from which all signals are broadcast to the receivers attached to the cable. The headend provides stable signal strength across the frequency range and is the location where channels are translated from one frequency band to another, where system control originates.

interactive system

As used in this report, an interactive system is one which permits the user or subscriber of service to interact with remote machines or people as in the case of terminals accessing timesharing computer facilities or communication between individuals typing at their own keyboards. Some systems (see teletext) give the appearance of being interactive, but do not satisfy this definition.

ITFS

Instructional Television Fixed Service. The kind of educational TV service currently operating at Stanford which is allocated by the FCC for that purpose. It is a non-mobile broadcasting station which, at Stanford, is comprised of four channels in the frequency range of about 2500-2686 MHz.

Low power television

A potential competitor with cable systems for delivery of programs to subscribers without requiring cable transmission. Transmissions can be selectively distributed to receivers in the assigned frequency range capable of receiving the signals. The FCC has recently allocated frequencies for this service.

LOTS

Low Overhead Timesharing System, the Stanford University computer facility which provides the principal resource for student computing activities in support of the instructional program. Currently, the facility makes use of DEC System 20 computers and supports concurrent connection of well over 100 terminal users.

MATV

Master Antenna Television systems. Commonly used in apartments and other multiple unit buildings. Like CATV on a smaller scale where all the units on a single system share the same antenna facilities. MATV distribution systems are not generally designed to be two-way.

MDS

Microwave or Multipoint Distribution System; an alternative to cable for the distribution of signals. A single microwave transmitter is used to distribute video and/or data over distances up to about 20 miles from the transmitter antenna. Each subscriber has a microwave reception antenna and receiver. These are different from conventional VHF or UHF television antennas and receivers. Signals are converted at the subscriber site from microwave frequencies to television receiver frequencies.

MSO (cable system operator)

A Multiple Systems Operator is a company operating more than one cable system franchise. Some of these companies are exclusively cable systems operators (e.g. Cross Country Cable) and others are more diversified enterprises (e.g. Times-Mirror, ATA-Time Inc.).

multiplex

To combine transmission of several messages, streams of data, voice telephone conversations or other signals on a single circuit or channel. This may be accomplished by a variety of means, for example, in frequency division multiplexing a separate frequency or band of frequencies is used for each message or stream in a way that they do not interfere with each other. In time division multiplexing, a single circuit which operates at higher speed than required for any single message or stream may be shared by dividing the time among the messages or streams.

off-air

Refers to television channels which are broadcast over the air by high power transmitters and which may be received by use of a suitable antenna within the area where the signal strength is sufficient. Community antenna cable systems (CATV) receive off-air channels, condition the signals so they are of nearly uniform quality and retransmit them over cable. The cable system headend equipment may translate off-air channels to different frequencies than those which are used for off-air transmission, so the television channel numbers for the stations received on cable may not be the same as the numbers for broadcast reception.

package programming

Television programs offered by various distributers (e.g. 20th Century-Fox, MGM, etc.) in a "pay window" (i.e. a limited time for the type of showings) for sale to resellers like HBO, Showtime, STV sytems, etc. for their retailing to cable systems, pay viewers and subscribers. Some packages may be offered with certain exclusive rights or limitations, others to all comers.

SMATV

Satellite Master Antenna Television. An alternative to cable television principally suitable to concentrations of users (e.g. very large apartment complexes) offered by independent installation companies who provide a satellite receiving station and distribution system to the customer (e.g. multiple unit owner) and arrange with distributors of satellite delivered services to provide programming of various kinds.

STV

Subscription Television, usually used to refer to an alternative to cable television systems which provides subscription television programming over the air using scrambled signals on regular broadcast channels (usually UHF) to prevent non-subscribers from viewing the programs. ON TV, Star TV and Select TV are examples of STV operations. STV operators may operate in one or more locations, using local signal origination. Regulations govern the STV services and currently limit the amount of time and hours that subscription programming can be broadcast, requiring the balance be allocated to commercial or other programming. Services can be tiered, for example, by time block or use of multiple transmitters.

SUNet

Acronym for Stanford University Network, the conceptual construct central to the recommendations of the "Ad Hoc Task Force on the Future of Computing at Stanford" in its 1981 report. SUNet was the name first given to the experimental digital network (3Mb ethernet) which evolved from within the Computer Science Department and now interconnects a number of computer systems and servers (printers, file systems). The SUNet name is now used to designate nodes in the institutional computing network which will be integrated into the future SUNet architecture. As envisioned by the Task Force, SUNet will become the University-wide digital network permitting interconnection of the many computer facilities, personal computers, thousands of terminals, word processors and other information sources and facilities in support of distributed information systems and technologies at Stanford.

teleconferencing

The use of two-way telecommunications facilities at multiple locations to allow communication among two or more individuals face-to-face from different locations. Suggested as a possible alternative for other types of meetings and conferences to reduce travel time and cost and, presumably, permit more rapid, impromptu arrangements.

tiering or tiered services

Refers to the packaging of services by cable system operators, STV and other subscription TV services so that the subscriber can select from different groups of services or packages. Usually a basic service is offered by cable operators consisting of at least the local off-air commercial and public channels, comprising the lowest tier. Family movies, adult movies, sports, live entertainment, special productions, childrens programs, news and other programming may be packaged to form one or more additional tiers for which additional subscription charges are made.

T-1 carrier

A transmission technique standardized by the telephone industry which multiplexes twenty-four channels (i.e. voice circuits) into a single digital channel at a digital signalling rate of 1.544 million bits/second.

Teletext

A method for data transmission in the blanking lines of a TV broadcast. Data is decoded and shown as frames on a television screen, superimposed on the TV image or as a full screen of data. The frames of data (a few hundred to a thousand per TV channel assigned to Teletext use) are repetitively transmitted and the subscriber selects a frame by following the instructions in menu frames, using a controller attached to the television set. The controller can grab selected frames from the sequence of frames being repetitively broadcast (on cable or off the air) and causes them to be displayed on the screen.

Videotex(t)-(Interactive Videotex, Viewdata)

Used now as a generic term, videotext is a class of systems or methods for delivery of text and pictorial (i.e. graphic) frames of information with some two-way capability to the subscriber. There is some considerable confusion in the use of this term. Viewdata (e.g. Prestel in England) is a videotex system that uses a telephone and one or more black boxes to convert a TV set into a data terminal via the telephone line. The images put on the TV screen are not broadcast (see Teletext) on cable or on the air, but sent at relatively low speed over the telephone line and decoded to permit video display. Other videotex systems transmit the data to and from the user/subscriber terminal over the same coaxial cable used for television services.

APPENDIX B

TO

REPORT OF THE

AD HOC TASK FORCE ON CABLE TELEVISION

STANFORD UNIVERSITY

STANFORD DEMOGRAPHICS RELATED TO RESIDENTIAL CABLE SYSTEMS

1. Adjacent Community Population Distribution - Faculty and Staff[1]

Locality[2]	No. of Faculty	No. of Staff	Total
Mountain View	21	1,122	1,143
Palo Alto	380	2,794	3,174
Menlo-Atherton-Portola V.	184	1,221	1,405
Los Altos-Los Altos Hills	99	583	682
Stanford+ (Zip 94305)	670	704	1,374
Totals	1,354	6,424	7,778
% of Total Population	89%	58%	62%

2. Campus Residential Housing Units

	Current	Under Construction	Projected
Dorm Units.....	3,070	800	800
Apartments.....	1,054	--	--
Faculty/Staff Housing....	834	140	2,000
Total Units.....	4,958	940	2,800

Notes: (1) Distribution based on March 1982 housing report. Includes main campus, Medical Center, SLAC and Emeritus faculty.
(2) Locality based on Zip codes.

APPENDIX C

Preliminary Analysis of the City of Palo Alto Position

The Steering Committee of the Task Force and members of the City staff have shared information about cable television and have had several informal conversations about affiliating with the City's cable system. Now that the consultants engaged by the City have rendered their engineering and economic reports [1,2] and the City staff has made its recommendations to the City Council [3], Stanford should proceed to assess its position relative to the City's likely direction and other alternatives, and should be prepared to provide input to the City Council and staff if invited to do so.

The City staff analyzed a number of ownership and operating options. These range from the conventional private franchise to a totally City financed, owned, and operated system. In between, there are a variety of hybrid models such as: joint ownership with a private company; a City built and owned system that would be contracted out to a private operator; a City owned system in which the City would act as broker to lease out various operating and programming capabilities; a City owned system in which it would turn over operation to a non-profit corporation or to a cooperative; and finally a system that would be City financed but owned by a non-profit corporation.

The City staff recommends municipal ownership and operation. The Task Force is uncertain how this course would impact Stanford's affiliation with the Palo Alto system. Although the City staff report[3] recommends provision of cable services to Stanford if appropriate agreements can be reached, it is not clear from City's reports that the option of a Stanford affiliation is seriously anticipated, as it is not covered in the economic study or in any of the discussions of financing. A letter has been directed to the City in an effort to shed more light on these particulars.

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(1) "CABLE TELEVISION FOR PALO ALTO: AN ENGINEERING STUDY," December 21, 1981, Hammett & Edison, Inc.
(2) "CITY OF PALO ALTO, FINANCING PLAN FOR MUNICIPAL OWNERSHIP OF CABLE TELEVISION," January 1982, Bartle Wells Associates
(3) "CABLE COMMUNICATIONS STAFF REPORT," April 15, 1982, City of Palo Alto

Although there are currently few municipally owned cable systems (approximately 30) this is a new wrinkle that more cities are currently considering because of the proposed federal legislation which would reduce the rights of cities to regulate cable television and which would also reduce or eliminate the obligation of private companies to provide public access and local programming. Further, cities regard cable television as a potential source of revenue to offset reductions in their tax-based revenues.

Most of the questions raised in our preliminary analysis of the proposed Palo Alto system are concerned with its operating and technical features which are independent of the issue of municipal ownership per se. However, it is our general view that if it chooses to municipally own and operate a cable system, the City may be forced to accept serious limitations in the capability of the system in order to reduce costs and keep financial risk to an acceptable level. We believe this view has been substantiated to date by the conservative nature of the engineering design alternatives considered and the staff report recommendations respecting the system options.

One additional concern directly related to municipal ownership is that it introduces political considerations in an otherwise straightforward business relationship which could make it considerably more difficult for Stanford and Palo Alto to work out a contract in contrast with negotiating with a private company which might be more willing to extend economic consessions to Stanford as a source of programming, an R&D partner, and a vital "laboratory" for development of new services.

Affiliation with the City of Palo Alto would have considerable potential benefits to the large number of faculty and staff who reside in the City if the system is designed to permit communications originating from Stanford to be delivered to those residences, particularly it if permits two-way communications and is compatible with our data transmission requirements.

On cursory reading, the report of the City's engineering consultant supports interactive services. However, on further inspection, the proposed engineering specifications are not particularly suitable to high-quality support of fully interactive services or the increasing range of broadband data equipment available in the marketplace. The Staff Report then recommends excluding even the modest data options ("Equipment for Experimental and Future Services", Recommended Options-Second Group) proposed by the engineering consultant.

Moreover, the Staff Report excludes or recommends deferral of the rest of the "Second Group" of options recommended by the engineering consultant including the institutional network ("Cable Plant Enhancements"). Unless we misunderstand the Staff Report, deferral of the institutional network would seem to exclude all portions of the non-residential Stanford campus and industrial park from the Palo Alto implementation plan for the next few years. Even if Stanford should otherwise cable its business campus, absence of the Palo Alto institutional system would preclude cable communication between Stanford and other Palo Alto institutions (e.g. hospitals and medical offices, industrial and research affiliates, businesses providing services to Stanford, Stanford units and organizations located in Palo Alto, etc.).

It is also questionable whether the City of Palo Alto, without close affiliation with a large system cable operator, can keep a municipally owned system current with the technology or competitive with the program offerings of the industry. The top five MSO's provide cable service to over 6.5 million residences and gross billions of dollars in their consolidated enterprises. Palo Alto's revenues are projected at about $6 million per annum; the industry revenues are about $4 billion per annum. MSO's may arrange for volume discount pricing on programming services (Home Box Office, etc.) which would be unavailable to a small independent operation in a city of Palo Alto's size. One might also anticipate that an independent system would have to wait longer in the queue to acquire equipment and service from suppliers, and that in the worst case, a small independent system might be deprived of access to scarce components and new technology. The large MSO's are investing substantial sums of money in research development of new services; one, not the largest by any means, has a staff of over 20 working on interactive systems development and is investing more than $2 million per annum in that project alone. The developments of the MSO's will most certainly be directed to the markets they are to serve, not the municipally owned or independent systems.

Another recent development in the industry is the potential interconnection of local systems to provide regional capabilities. One of the earliest associations of this kind was announced in early May between Viacom and Gill Cable, which together serve much of the peninsula. They have formed a jointly owned enterprise aimed at supplying interconnection services among their cable systems on the peninsula which will permit shared programming and extended

communication. Larger systems are likely to come together in this way and permit access to a greatly expanded set of programming and communications services as a result.

Because of these uncertainties, and particularly in view of the unclear position of the City with respect to an affiliation between Stanford and Palo Alto pending completion of deliberations by the City Council, we feel it is in Stanford's interests to explore all options, including affiliation with other neighboring systems and especially the option of Stanford contracting with a private company.

The following pages summarize the direct references to Stanford found in the Consultants and Staff Reports and provide some observations pertaining to the engineering consultant's proposed technical spseicifications for the City system.

Direct Citations Applicable to Stanford University from the report:

"CABLE TELEVISION FOR PALO ALTO: AN ENGINEERING STUDY"
Hammett & Edison, Incorporated

The following underlined material is excerpted from the above report. Stanford's Task Force remarks follow each excerpt, where we had observations to make.

SUMMARY SECTION

(Page 3 - Recommendations)

5. Carry the four channels of instructional television now broadcast by Stanford University on the Instructional Television Fixed Service system, if arrangements can be made with Stanford. As future arrangements can be made, carry other local cultural, entertainment, and sporting events.

> This recommendation was deleted in the City Staff report. The first part is not entirely consistent with Stanford's position which was clarified by letter to the City.

(Page 5 - Recommendations)

24. Provide service to Stanford University if appropriate agreements can be reached on terms and fees. Serve Stanford with three sub-nets from the central hub for the faculty housing, student housing, and central campus areas. At Stanford's request, route the system serving the central campus through a sub-hub located on campus to permit flexibility in diagnosis of failures in vital computer services delivered to this area.

> This is consistent with discussions between the consultant and Stanford representatives about preferred configurations to meet Stanford's needs.

SECTION I - SYSTEM REQUIREMENTS

(Page I-4) Stanford is quite interested in exploring participation with Palo Alto in any proposed cable system. Three service areas have been defined: the central business area; the student housing areas, including the married student housing; and the faculty housing area. There are also numerous students and faculty living within Palo Alto itself.

Stanford's uses for the system, in addition to the normal services that would be carried on the system, would include: distribution of programming now carried on the Instructional Television Fixed Service (ITFS) system, with the possibility of more than the existing four channels being utilized; distribution of taped programs of selected recent classes for student review; and extensive carriage of data between Stanford computer systems and locations both on and off campus, to be utilized by students, faculty, and possibly the public. The Stanford uses require a system on which programs can be directed to specific users and which provides full accountability for program usage. It is possible that Stanford will also permit some

cultural and sporting events originating on campus to be distributed through the system. Thus, Stanford will likely provide several channels of programming to the system, and utilize several channels for its own functions.

Stanford desires that the cable system serving the central business area be routed through a sub-hub on campus, preferably at the computer center, to permit Stanford personnel to rapidly diagnose any failure of service and determine whether computer center equipment or cable system equipment is at fault.

The foregoing is generally consistent with discussions held between Stanford Task Force representatives and the City's consultant. Hub location nearer the central quad is also a reasonable alternative. Isolation of Stanford trunks by separate sub-hub distribution would definitely be desirable. Other alternatives would be an entirely independent hub with supertrunks connecting it with the Palo Alto hub for program sharing. This makes more sense if the two relatively independent systems have differing design specifications and configuration requirements.

(Page I-11) The proposed facilities include equipment for two small packet data networks, to permit experimentation. One network may be used by the City and library services, and another might be used by the Palo Alto Unified School District. Stanford is likely to provide equipment for a substantial network of both low speed and high speed data transmission for its own use.

Stanford would have to provide its own facilities given the extremely modest and conservative data capabilities initially proposed for the City system.

SECTION II - SYSTEM CONFIGURATION

(Page II-18) Institutional Network: The first sub-net includes the downtown Palo Alto area and the main city buildings, and would extend to the Stanford Shopping Center, Stanford Hospital, and the Professional Center, if the decision is made to extend beyond the city limits in those areas.

The City Staff Report and the Financing Plan for Municipal Ownership propose deferral of the institutional network with no indication of the likelihood of future implementation. This would substantially reduce the expected value of the system to Stanford.

(Page II-24) Potential Other Communities:

Community: Stanford
1970 Population: 8,691
Population Factor: 0.16
Construction Factor: 0.16

The factor for Stanford has been estimated in more detail due to the high likelihood that Stanford will be served by the system.

It is not clear what this means. From the revenue production standpoint, we believe it is likely that the resident Stanford faculty and staff

areas would be heavy subscribers to pay cable services, particularly if University programmatic materials were available and two-way data services were supported. Student residential areas might be a different matter. However, if a policy of providing low-cost connectivity to high density housing were adopted or negotiated for student residences and the services were of value to residential education programs as well as of entertainment interest, it is possible that 100% subscription could be warranted. The relative construction cost per population unit (Construction Factor) seems a little mysterious. For example, if conduit capacity is available and passes near many of the residences, the factor is probably high, otherwise it could be low. More detailed projections of both costs and revenue seem warranted.

(Page II-25) Service to Stanford: Service to Stanford would consist of additional distribution system and subscriber facilities generally similar to those described earlier for Palo Alto. Stanford contains three distinct areas and it is proposed that each be served with a separate sub-network. These are the central business, the student housing, and the faculty housing areas. The service to the two housing areas would be similar to other residential service except that service to the student housing involves primarily multi-unit buildings. Since these areas would be fed separately from the main distribution hub, Stanford would have the option or arranging any desired programming on the spare channels.

At Stanford's request, service to the central business area would be provided in a slightly different manner. One of the main requirements for cable service in this area is to deliver services between Stanford computers and major users on campus. If a failure of this service occurs, it is desirable to be able to diagnose quickly whether the problem is in the computer equipment or in the cable distribution system. The proposed configuration includes two-way trunks between the main distribution hub of the system and a sub-hub located on the campus, possibly at the computer center. (Note that this sub-hub concept is similar to the future sub-hubs for the main Palo Alto distribution system.) Service to the campus business area would originate via one or more cables from this sub-hub, and diagnosis of system failures could take place from this single point.

It is assumed that the Stanford distribution cable system will utilize three cables in the same manner as that of the main City system, but with drops to individual users only as required by the services to be used. Much of the Stanford system will involve new underground construction, with the result that the construction of the three-cable trunk system will not be much more expensive than any installation of lesser capacity.

Without more careful study, it is not clear how much new underground construction is required or whether it could be reduced by alternative configuration options (e.g. a separate sub-hub for the residential sectors). Most of the foregoing is derived from consultant's discussion with Task Force representatives, but it represents one of a number of possible scenarios which need to be compared on a cost/benefit basis.

SECTION III - REVENUES AND EXPENSES

(Page III-5) Service to Stanford: The capital investment for service to Stanford was estimated separately from that of other communities:

Capital Investment Category	Est. Initial Investment
Central Facilities	$ 65,000
Distribution System	730,000
Subscriber Premises Equipment	260,000
Sub-hub at Stanford	130,000
Adressability Function	130,000
Cable Plant Enhancements	45,000
Security Services	85,000
Total	$1,485,000

No effort has been expended by the University in validating the above numbers. An engineering study of the central business portion of the campus is underway and will be completed by the early summer. Additional facts regarding the residential and outlying areas need to be gathered for validation.

The following UNDERLINED sections are from the Technical Specifications portion of the same report as above, pages I-18 to I-22. Material without underlining constitutes comments which are provided for clarification or to point out potential problems.

Television Signals

1. Channel Assignments. The frequency boundaries will be fixed based upon whether an harmonically-related carrier (HRC) system is used. If an HRC system is not used, the 12 standard VHF channels must be as specified in Section 73.603(a) of the FCC Rules, with additional channels assigned as in common cable television practice. If an HRC system is used, the frequencies will be assigned as specified by the manufacturer.

   The HRC (Harmonically Related Carrier) system advised by the City's consultant provides a means for reducing intersignal interference by making intermodulation beats fall on carrier frequencies. According to experts in two-way systems and CATV engineering, it can provide about 10 dB reduction of CTB (Composite Triple Beat) interference BUT is not suitable for mixed (data plus video) systems. Also, HRC equipment is currently available from only a very small number of suppliers. Limited competition is likely to make the costs of HRC high. Specification of allowable signal-to-interference levels should suffice, regardless of the system used.

5. Synchronous Carriers: All VHF broadcast signals carried on channel on the cable within their Grade B contour should be synchronous (phase locked) with the original broadcast signals, if an HRC system is not used.

   The purpose of synchronous carriers for strong local VHF signals is to prevent low frequency beats between the cable and local signals picked up directly because of inadequate receiver shielding. This would be done probably as a matter of course if signals are not to be translated to other channel frequencies.

6. Subscriber Signal Levels: The visual carrier level (defined as the RMS visual carrier voltage during synchronizing pulses across a 75 ohm termination) should be a minimum of + 6 dBmV at each subscriber terminal. The maximum level should not exceed + 2- dBmV.

Subscriber signal levels (of video signals) from +6 to +20 dBmV are appropriate for good picture quality with standard TV sets, and follows good practice and CCIR guidelines.

8. Adjacent-Channel Visual Carrier Levels: Levels of any visual carriers with a nominal 6 MHz frequency separation should differ by no more than 2 dB.

Adjacent signal levels within +/- 2 dB is about as good as can be expected. This is marginal for some TV receivers to avoid interference between adjacent channel signals (the FCC recommends that adjacent channel signals be 15 dB BELOW the desired signal, but this is not feasible on a cable system where all channels are to be assigned). The better and more recent TV receivers, particularly those designed for cable, should be OK with this, and this is probably typical of most cable systems.

9. Overall Visual Carrier Levels: No visual carrier level should differ by more than 10 dB from any other visual carrier level.

TV signal levels within 10 dB should be OK, as long as 6 is met. This includes both the +/3 dB of the system and other variations due to propagation and head-end equipment.

11. Cable System Noise: The noise generated within the system should be such that the ratio of visual carrier level to the RMS noise voltage in or referred to a 4 MHz bandwidth located within the assigned channel is greater than 44 dB.

Carrier-to-Noise ratio of 44 dB is probably adequate if it can be held for all services, including especially subscriber equipment. There is no specification of permitted levels of external signal ingress, which can be a serious problem below 54 MHz. A specification of allowable signal-to-interference levels is probably adequate, however.

12. Total Noise: The total RMS noise voltage, as measured at baseband during normal carriage of each assigned signal, should be such that the ratio of the visual carrier level to the RMS noise voltage in or referred to a 4 MHz bandwidth located within the assigned channel is greater than 41 dB.

13. Intermodulation Products: The RMS level of any signal intermodulation product or other unwanted coherent signal within any 6 MHz channel should be at least 60 cB below the visual signal level. The RMS level of all such signals within any 6 MHz channel, when combined, should be at least 50 dB below the visual carrier level.

14. Cross-Modulation Level: Cross-modulation products, as defined and measured in accordance with NCTA specifications, should be at least 55 dB below the visual carrier level.

11,12,13,14 OK, standard practice or better. Signal levels in main and feeder trunks should probably be specified.

17. Subscriber Terminal Isolation: The isolation provided to each subscriber terminal from any other subscriber terminal should not be less than 30 dB over the frequency range from 5 to 400 MHz, except that the isolation between separate subscriber terminals of the same subscriber should not be less than 15 dB.

Isolation of 30 dB is probably OK. This relates to spurious receiver radiations creating interference for other users. If user equipment was malfunctioning then almost any specified isolation might not be adequate and diagnostic/service procedures would have to be used to locate and isolate the problem. Doubtful that the system could reasonably be designed or specified to avoid this. The specified isolation between terminals of the same subscriber could be higher, since standard taps and splitters normally provide 20-25 dB of isolation.

(Page I-21)
Other Signals: Carriage of outgoing and return signals for data and other purposes may proceed in accordance with equipment manufacturers specifications for each service, provided such carriage does not degrade other signals below their appropriate standards.

This seems to be a VERY minimal specification and discussion of data transmission over a cable system. The phrase "not degrade other signals below their appropriate standards" can be interpreted to cover almost anything. It says little about interference to the data signals themselves, and presumably assumes that equipment manufacturers' specifications are appropriate and adequate. In the rapidly changing data equipment evolution, however, it may be difficult to anticipate future problems. Our measurements of the emissions from one vendor's rf modems (Sytek/LocalNet System 20) have shown them to be very clean and well filtered as far as generation of spurious signals and noise outside of their band, and hence they would probably meet a more rigorous interference standard that given above. Data transmission equipment may not be particularly spectrum-efficient, however. Data equipment specifications should consider data rate vs. bandwidth in order to encourage manufacturers to be efficient in this respect.

In general, the specifications seem to deal with a video transmission system and not to address the requirements specific to data transmission and volume data usage of bandwidth in the reverse direction (to the headend/hub). Reverse direction signal balance and system design to insure rapid diagnosis and isolation of reverse direction system noise, signal ingress, streaming modems, etc. do not seem to be addressed. These would be of major importance on the institutional system and for Stanford on its systems.

There is no mention of Stanford, per se, in the report covering the "Financial Plan for Municipal Ownership" because the options involving Stanford were excluded from consideration in that study.

The following excerpts from the "CABLE COMMUNICATIONS STAFF REPORT," By the City of Palo Alto contain references to Stanford or recommendations which might relate to Stanford. They are provided without comment as background information to the "Preliminary Analysis," which precedes.:

Page No.

SUMMARY OF RECOMMENDATIONS

3 8. Legislation:
The Council should direct staff to continue discussion with neighboring communities that express interest in joining the Palo Alto System.

PROJECT DEVELOPMENT

5 In addition to the internal task force, the staff has explored with and/or received input from various community organizations, businesses and institutions, such as: Palo Alto Unified School District, Standing Committee on the Arts and Sciences, Palo Alto Cable Cooperative, Peninsula Cable Television Committee, Palo Alto Medical Foundation, Senior Coordinating Council, Downtown Coordinating Council, Common Cause, Stanford University and Medical Center, Foothill College and companies in the Stanford Industrial park on the paotential impact and uses of a cable communication system. Staff has also discussed the issue of a cable communication system in Palo Alto with a number of individuals in the community who have expressed a personal or professional interest in the system.

EXTENDING SERVICE TO OTHER COMMUNITIES

22 In earlier discussions with the Council, the staff raised the possibility of cooperative efforts with nearby communities to provide cable communication services. While the Council has not taken a formal position on the issue of cooperative cable efforts, the staff suggests that if Palo Alto decides to own and operate its own cable system, consideration be given to extending services to neighboring communities. Palo Alto and the other communities that shared a system could benefit from a collaborative use of resources, programming and other services. In addition, Palo Alto could profit from an expanded service area through increased revenues and cost reductions due to economies of scale.

Page No. 22 (cont.)

The Hammett and Edison engineering study states that it is feasible for the proposed cable system to provide service to communities within a radius of seven miles. Many of the communities within that area do not currently receive cable service. To date the staff has had discussions with the Cable Task Force at Stanford University and the Mid-Peninsula Cable Advisory Board of Menlo Park, Atherton, East Palo Alto and San Mateo County representatives.

These groups are actively exploring the acquisition of cable services and have shown some interest in cooperating with Palo Alto, should it approve municipal ownership.

To extend a cable system beyond the city limits of Palo Alto requires that:

1. neighboring communities be interested in such cooperation
2. services to interested communities be mutually beneficial, both economically and politically
3. a partnership or contractual arrangement reflect thorough study of:
   a. our financial risk and potential revenues
   b. our interest in operating beyond our city limits
   c. their interest in being served by another municipality
   d. legal restrictions.

SYSTEM DESIGN AND ENGINEERING RECOMMENDATIONS

(Note: The following recommendation 5. from the engineering consultant's report was referenced in the staff report but not concurred in by the staff.)

31. 5. Carry the four channels of instructional television now broadcast by Stanford University on the Instructional Television Fixed Service system, if arrangements can be made with Stanford. As future arrangements can be made, carry other local cultural, entertainment, and sporting events.

(Note: The following recommendation number 24 from the engineering consultant's report was concurred in by the City staff.)

33. 24. Provide service to Stanford University if appropriate agreements can be reached on terms and fees. Serve Stanford with three sub-nets from the central hub for the faculty housing, student housing, and central campus areas. At Stanford's request, route the system serving the central campus through a sub-hub located on campus to permit flexibility in diagnosis of failures in vital computer services delivered to this area.